

Round Rock ISD – 2008-09
Lesson 1 – Grade 3 Measurement Kit

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Broken Rulers and Line It Up!* - A Length Measurement Lesson

*Lesson is adapted from two activities in *Sizing Up Measurement: Activities for Grades 3-5 Classrooms*, by Chris Confer, Math Solutions Publications, 2007, and an activity in *Mathematics TEKS Refinement 2006 – K-5*, Tarleton State University.

Mathematics, Grade 3

Materials:

- **Paper Ruler**, 1 per pair of students, already cut out from a copy of the attached black line master. You can also find this ruler at: http://www.vendian.org/mncharity/dir3/paper_rulers/UnstableURL/ruler_foot.pdf
(Make sure printer setting is set to "no scaling" rather than "fit to page," etc., so that ruler will print out as accurate 12-inch scale.)
Optional: Print rulers on cardstock.
- **Student Page: "Line It Up! Recording Sheet,"** 1 per student
- pair of scissors for teacher
- 3x5-inch index cards, 1 per pair of students
- 5x8-inch index cards, 1 per pair of students
- 1-inch color tiles, 5 per pair of students
- 1-inch color tiles, 8 for teacher; line up color tiles side-by-side and tape together using clear adhesive tape – makes an 8-inch "ruler"
- crayons, at least 4 of different colors per pair of students
- 12-inch rulers, with inches and centimeters, 1 per pair of students
- meter sticks, 1 per group of 4
- paper strips made from adding machine tape, 1 per group – already cut out prior to starting lesson
- variety of items to measure, including pencils, whiteboard, floor, rug, boxes, newspapers, magazines, etc. (see list on the "Line It Up! Recording Sheet")
- red and black markers (or any two contrasting colors that will show up), 1 of each color for each group
- scissors, 1 pair for every 2 students

TEKS/SEs:

- 3.11 – directly compare the attribute of length, and use comparative language to solve problems and answer questions; select and use standard units to describe length.
- 3.11A– use linear measurement tools to estimate and measure lengths using standard units.

Objective 6 TEKS/SEs (Underlying Processes and Mathematical Tools):

- 3.14A – identify the mathematics in everyday situations
- 3.14B – solve problems that incorporate understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness
- 3.14D – use tools such as real objects, manipulatives, and technology to solve problems
- 3.15A – explain and record observations using objects, words, pictures, numbers, and technology
- 3.15B – relate informal language to mathematical language and symbols
- 3.16A – make generalizations from patterns or sets of examples and nonexamples
- 3.16B – justify why an answer is reasonable and explain the solution process

Technology

- 3-5.2.A – use a variety of input devices such as mouse, keyboard, disk drive, modem, voice/sound recorder, scanner, digital video, CD-ROM, or touch screen;
- 3-5.7.C – use a variety of data types including text, graphics, digital audio, and video.

Lesson objective(s):

- Students explore, in a problem-solving situation, a length measurement problem in which they confront common misunderstandings about the meanings of the lines, spaces, and numbers on a ruler.
- Students build a better understanding of linear measurement by constructing a meter stick and using this tool to measure length.
- Students compare and order objects according to length based on their measurements.

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- Students explain their solution strategies and justify their solutions.
- Students record their solution methods using words, pictures, tables, numbers and symbols

Differentiation strategies to meet diverse learner needs:

- Problem- solving, inquiry-approach
- Hands-on exploration
- Collaboration and discussion

Vocabulary:

- Alternating, centimeter, distance, equal, foot, inch, length, longer, meter, meter stick, Metric, paper strip, ruler, shorter, space, zero

(Note: prior to this lesson, students need to have developed personal benchmarks for an inch, such as the length of their thumb from the knuckle to the tip, the length of a small paper clip, the diameter of a quarter, etc.)

ENGAGEMENT

- Technology Option: This [UnitedStreaming video clip](#) can be used to discuss with students how variances in the tools they use can potentially produce inaccurate measurements. (Teacher will need to login to view video. See campus IT for login information.)
 - Ask the students “If your ruler is broken will you and your neighbor both get the same measurement?”
- Hold up a 3x5-inch index card and tell students that they will be measuring the sides of cards this size. Ask students to tell what they notice about the sides of the cards. Likely, they will say that the top and bottom are the same length and that the left and right sides are the same.
- Hold up one of the paper rulers and tell students that you are going to “break” the rulers by cutting of some of each ruler, and that the rulers will be broken in different ways.
- Cut off the first inch and the last inch of the ruler you are holding. [Previously you may have already “broken” the rest of the rulers in different ways: be sure to cut off at least the first three-quarters of an inch and to leave at least nine inches in a row visible on the entire ruler.]
- Ask students, “What do you think will happen when you measure the cards that are all the same using the rulers that are all broken in different ways?” “Will the measurements of the sides of the cards be the same or different? Why?” Have students discuss what they think. The discussion should end with consensus that since the cards are all the same, everyone should find the same measurements.

EXPLORATION – Broken Ruler

Part 1:

- Provide each pair of students with a 3x5 index card and a broken ruler; students should have paper for recording results.
- Tell students to find the length of each side of the index card and to record what they find out using pictures, words, and numbers.
- As the pairs work together on the problem, observe how the students use their broken ruler. Likely, some students will misinterpret how to use the ruler. Some may line up the left end of the ruler with the left end of the card and read the number that lines up with the other end. Others may count all the numbers that are visible, or count the visible numbers and also count the number(s) that was (were) cut off from the end of the ruler.
- *Don't correct students.* Allow students to use the strategy that currently makes sense to them, but ask them why they think their measurement is correct. Students who have difficulty do not understand how the ruler represents space or distance. During the discussion, later in the lesson, they will confront this misunderstanding as they realize that they do not have the same measurements as others do.

Part 2:

- On the board or chart paper, make a chart with two columns labeled “Long Side” and “Short Side.”
- Bring students together for a class discussion. Tell students that you observed students thinking about their broken rulers in different ways. Ask several pairs to share their measurements for the sides of the cards (record these on the chart) and explain how they figured them out. Students are likely to have different measurements

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for the same dimensions of the card. *Do not indicate which measurements are correct or incorrect.*

Part 3:

- Remind students that earlier they had concluded that everyone should find the same measurements since everyone has the same sized card to measure. Ask them to use what they know about inch benchmarks to help them understand how the ruler functions: "About how long is an inch? Show me or explain to me." "Show me with your fingers how long an inch is." Ask them to look at the card and use the benchmark for an inch to help them estimate the length of the long and short sides of the card. (Doing this should help students be able to answer the next set of questions in the bullet below.)
- Ask students to look at their ruler. "Where is each inch represented on the ruler?" "What are you counting when you use the ruler? Are you counting the numbers? Are you counting the space/distance between the numbers?" Students should compare the benchmark for an inch with the space between the numbers on the ruler to see that they are counting the spaces between the numbers to measure length with a ruler.

Part 4:

- Ask student to turn over their papers. Tell them to use their broken rulers to check their measurements for the long and short sides of the card and to record on their paper what they think now and why they think their measurements are correct.
- Bring students together again to share. Have the pairs describe how their ruler was broken by telling which numbers are visible on their ruler. Then have them talk about what they thought about the measurements of the card at first, and what they think now and why. On the chart, draw a line under the first list and record the new measurements. Have several of the pairs share, trying to select some who have changed their answers.

Part 5:

- Show students the strip of color tiles that you have taped together. Lay the strip against the edge of an index card and help students see how the length of each tile matches the inch-long space that each number on the ruler represents.
- Provide each pair with 5 loose color tiles. Ask students to use these to check the measurement of their own index card. Check to be sure that students are measuring with tiles side by side with no gaps. Ask students to trace and color those squares right on their broken rulers, so that adjacent squares are different colors. This will help students better visualize the spaces that the numbers represent. Check to be sure students are aligning the tiles correctly to trace the squares onto their rulers.
- Collect the broken rulers so that they can be used the next day for a similar activity.

Part 6:

- Provide students with a ruler. Ask students to summarize the lesson by explaining, either in a discussion or individually in writing, what the numbers represent on a ruler. What are we counting when we measure with a ruler? (The numbers represent the entire length of that many inches, and we are counting the units of space between the numbers.)

Part 7:

- The next day, repeat the activity in Parts 1, 2, 4, and the second part of Part 5 above, except: (1) use 5x8-inch index cards; (2) ask students to estimate the long and short sides before they have any tools or the broken ruler; (3) give pairs a different broken ruler than they had the day before and (4) only provide pairs with one color tile when you get to Part 5.
- During a group discussion at the end of the activity, have students discuss their correct (and incorrect) strategies and come to a consensus on strategies that work when measuring with a broken ruler. For example, students may mention the following successful strategies: (1) Line up the broken ruler as if it were a regular ruler, read the final number, and then subtract the inches that were cut off. (2) Line up the broken ruler with any number matching the end of the card, and count each space that touches the card.
- Ask students to help you "fix" one of the broken rulers. Display the ruler and have them describe how to draw the missing part. Discuss whether the number at the left end of the ruler is 1 or 0. (It is 0 because the ruler's left end represents the initial starting point – no distance at all.)

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BASIC UNDERSTANDINGS:

- When we measure length, we count the spaces between the numbers on the ruler.
- The “0” at the left end of a ruler indicates the starting point and “no distance.”
- The numbers represent the entire length of that many inches. When the “0” mark on the ruler is lined up with one end of the length being measured, the number that lines up with the other end of the length being measured is the number of inches of that length.
- There are no gaps or overlaps when measuring length.
- If the end of the length being measured is lined up with another number on the ruler than 0, then the difference of the numbers on the ends of the length being measured will give you the number of inches in between. You could also count the spaces between numbers to find the number of inches.
- A ruler is a special kind of number line where the distance between each whole number is one inch (or one centimeter).
- One foot is the same as 12 inches.
- One meter is the same as 100 centimeters.

EXPLANATION

- Students will explain their thinking and justify their solutions in groups and in whole-class discussion, as well as with tables, diagrams, and written explanations. See activities in “Exploration,” “Elaboration,” and “Evaluation.”

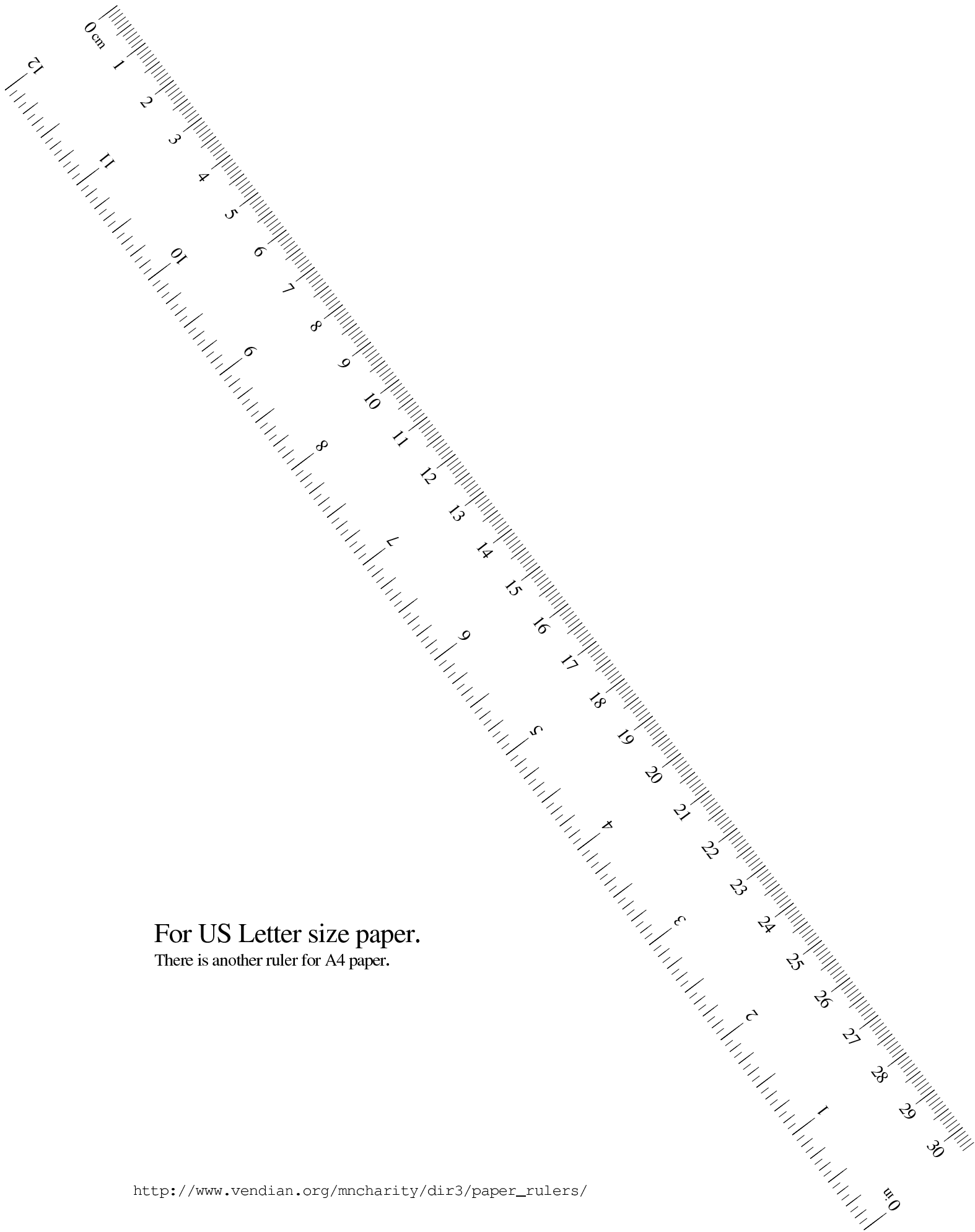
ELABORATION – Line It Up!

Part 1:

- Provide students with a ruler with centimeter markings (1 per student), meter sticks (1 per group), adding machine tape paper strips – at least a meter long (1 per group), two contrasting colors of markers (per group), and pencils (1 per student).
- Follow steps 1 – 4 in the teacher directions for the attached “Line It Up!” activity from *Mathematics TEKS Refinement 2006*.

EVALUATION

- On the board draw a rectangular card and a broken ruler underneath. Make the card 8 inches long and place a broken ruler under it showing from 16 to 24 $\frac{1}{4}$, except, do not show the number 16. Show the ruler tick marks from 16 to 24 $\frac{1}{4}$ but only the numbers from 17 to 24. Ask students to (individually) figure out how long the bottom of the card is and explain their strategy and thinking using words, pictures, and numbers. (If a student is stumbled by the missing number 16, ask him or her to draw the missing part of the ruler.)
- Do students use accurate and efficient measuring strategies? Do they have an effective strategy for measuring with a “broken ruler”?
- Do students understand that when measuring using a ruler, they are counting the spaces between the numbers?
- Do students understand that the numbers on a ruler represent the entire length in inches (cm) from the 0 end of the ruler to the tick mark for that number?
- Are they avoiding gaps and overlaps when measuring length?
- Do students make reasonable estimates/predictions? On what do they base their estimates/predictions?
- Do students have a benchmark for how long an inch is? how long a centimeter is?
- Are students able to determine the reasonableness of their solutions and the solutions of others?



For US Letter size paper.

There is another ruler for A4 paper.

Measurement

Activity: Line It Up!

TEKS: (3.11) **Measurement.** The student directly compares the attributes of length, area, weight/mass, and capacity, and uses comparative language to solve problems and answer questions. The student selects and uses standard units to describe length, area, capacity/volume, and weight/mass.

Note: Portions of this lesson address TEKS at other grade levels as well; however, the intent of the lesson fits most appropriately at the grade level indicated.

Overview: According to John A. Van de Walle, a good instructional plan for measurement includes three vital steps. The first step is to ensure the student's understanding of the specific attribute being measured. Demonstrations and discussions that include comparisons (longer/shorter) based on the attribute will give evidence of the level of understanding the student has attained. The next step is to use models to concretely match the attribute with a standard unit that is used to measure the desired attribute (cm, inches, etc...). This crucial concrete step is where a quantitative measurement is produced. The final step addresses the problems students have relating how a measuring device works with using the device. To address this problem area, students should use an array of measuring devices including standard tools such as rulers and meter sticks as well as tools made by the students, such as a strip of tag board or paper that students have marked off in units.


In this lesson, students will build a better understanding of linear measurement by constructing a paper meter stick and using this tool to measure the length of several objects. In addition, students will compare and order objects according to length based on their measurements.

Materials: Ruler with centimeter markings, one for each student
Meter sticks, one for each group of students
Paper strips made from adding machine tape, one for each group of students
Variety of items to measure including pencils, chalkboard/whiteboard, floor, rug, boxes, newspapers, magazines, etc... (see list on the recording sheet)
Red and black markers, for each group of students
Scissors, 1 pair of scissors for every 2 students
Line It Up! – Recording Sheet, one per student

Grouping: 2 students per group

Time: 2 – 3 class periods

Lesson:

Procedures	Notes
<p>1. Have each group of students create a paper meter stick marked off in centimeters on the paper strips. Students should use a purchased meter stick as a guide for marking off the centimeters.</p> <p>After marking the centimeters on the paper strips, students should color each centimeter, alternating between red and black (or any two other contrasting colors). In addition, the students should number the centimeters from 1 to 100 inside the boxes. See the diagram below.</p>  <p>Note: Only one-tenth of the paper meter stick is shown above. Alternating colors and numbering inside the boxes reinforces the concept of measuring the length between the tic marks, rather than counting tic marks.</p>	<p>This portion of the lesson will take some time to completely color-code their paper meter sticks. While the students are working on them, discuss concepts such as the following:</p> <ul style="list-style-type: none"> • Why the numbering is inside each box.... (reinforces that the length between the tic marks is more important than the tic marks or the numerical labels) • How each box is congruent and measures one centimeter in length...
<p>2. Direct students to find the items listed on the recording sheet.</p> <p>Have students measure the length of each item in centimeters using their paper meter sticks and record their measurements on the recording sheet.</p> <p>As you monitor the groups while they measure, ask guiding questions such as the following:</p> <ul style="list-style-type: none"> • How many red centimeters did you measure? • How many black centimeters did you measure? • What is the total of all the centimeters (red and black)? • Do you get the same total of centimeters if you start measuring at the opposite end of your paper meter stick? • Could you get the same total only using a 	

Procedures	Notes
piece or part of your paper strip?	
<p>3. Have each group present one item and explain how they measured its length.</p> <p>The guiding questions listed in the previous procedure would work well during this whole group debrief as well.</p>	
<p>4. Have students compare/sort the collection of objects according to length and record findings on the recording sheet.</p>	

Assessment: The recording sheet and teacher observations serve as assessment tools throughout the lesson.

Extensions:

1. Direct students' attention to a specific reference item. Then have students compare a variety of items to the reference item, sorting them into two groups: "shorter than" or "longer than." Provide students with a different reference object occasionally to produce different sorts.
2. Have students collect or record a list of items that are "longer than," "shorter than," or "equal to" a given dimension (one foot, one inch, one centimeter, etc...).

Resources: Lovin, L.H., & Van de Walle, J. A. (2006). Teaching student-centered mathematics: Grades 3-5. Boston: Pearson Education, Inc.

Van de Walle, J. A. (2004). Elementary and middle school mathematics: Teaching developmentally. Boston: Pearson Education, Inc.

Line It Up!
Recording Sheet

Item	Length in centimeters
Length of an unsharpened pencil	
Width of the door	
Width of a sheet of paper	
Length of a shoe	
Width of a poster	
Length of chalk or a dry erase marker	

List the items from the table in order from longest to shortest.
